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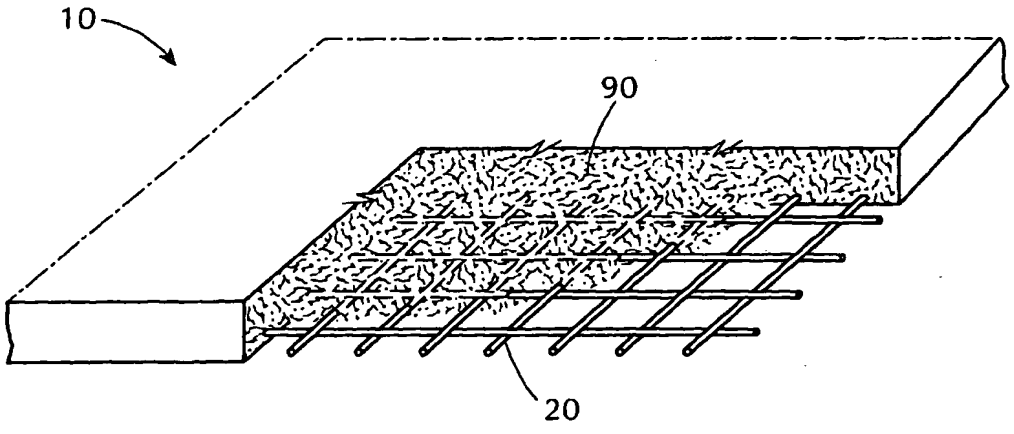
(54) Title: TEAR-RESISTANT FIBERGLASS REINFORCED PLASTIC PANEL AND METHOD OF MANUFACTURING SUCH PANELS



(57) Abstract: The invention is directed to fiberglass reinforced plastic panels having increased tear resistance. Increased tear resistance is provided by an open-weave scrim which is incorporated into the panel. The panels are useful in the manufacture of truck bodies and trailer roofs.

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TITLE

TEAR-RESISTANT FIBERGLASS REINFORCED PLASTIC PANEL AND METHOD OF MANUFACTURING SUCH PANELS

BACKGROUND OF THE INVENTION

Field of the Invention

The invention is directed to a fiberglass reinforced plastic panel that can be manufactured on a continuous line. The panel, which may be translucent, incorporates a scrim to improve tear resistance. The invention is also directed to a truck body or trailer roof incorporating the fiberglass reinforced plastic panel of the invention.

Fiberglass reinforced plastic (FRP) panels are commonly used as a structural material in dry van (non-refrigerated) trailers and truck bodies. The translucent FRP panel has been successful in replacing aluminum sheeting in this type of application because

of the unique benefits it offers to the trailer manufacturer and owner. One benefit of a translucent FRP roof panel is that it allows light into the trailer and makes loading and unloading of the trailer safer and easier.

FRP panels according to the prior art typically incorporate chopped fiberglass saturated in the resin matrix to achieve improved in-plane (tensile) strength properties. However, the fiberglass fibers become brittle, so that when the panel is subjected to an out-of-plane stress (tearing motion) the panel matrix fractures easily.

When a puncture or tear occurs in the trailer roof, the tear propagation characteristic of the current FRP roof panel is significantly different from that of an aluminum roof panel. A dry van trailer with an aluminum roof will resist additional tear propagation from the original damaged area. Wind forces generally simply bend the torn aluminum back as a flap.

By contrast, a FRP panel that is punctured or damaged will experience tear propagation due to brittle failure at the tear line, and subsequent exposure to wind forces during the over-the-road operation of the trailer.

Description of the Related Art

U.S. Patent No. 4,619,954, incorporated herein by reference in its entirety, discloses a fiberglass

reinforced plastic structure comprising a polyester resin, crosslinking monomers, additives and fillers. The structures made are useful as highway signs.

U.S. Patent No. 3,886,016, incorporated herein by reference in its entirety, discloses structural members made of synthetic resins reinforced with chopped fiberglass fibers. The structural members comprise a cylindrical wall to which are attached ribs of fiberglass matting. The disclosed members are useful for the manufacture of underground storage tanks, drainage conduits and the like.

U.S. Patent No. 4,451,528, incorporated herein by reference in its entirety, discloses structural components made by compression molding a prepreg. A prepreg is a fiberglass mat impregnated with resin. The mat used for the prepreg must have a close weave with sufficient void space that the resin can be infused into it.

U.S. Patent No. 5,763,043, incorporated herein by reference in its entirety, discloses open weave fabric grids that are used for reinforcing stucco layers on walls, particularly rigid foam insulation boards.

SUMMARY OF THE INVENTION

In one embodiment, the invention comprises a tear-resistant fiberglass reinforced plastic panel comprising: a resin; a plurality of fiberglass

filaments dispersed in the resin; and an open weave scrim in the resin.

In preferred embodiments, the tear resistant panel incorporating the scrim is a translucent panel used in truck bodies and trailer roofs.

In other preferred embodiments, the tear-resistant fiberglass reinforced plastic panel according to the invention is continuously cast and cured in curing ovens from a mixture of catalyzed liquid resin and chopped fiberglass. The catalyzed liquid resin saturates the chopped fiberglass, and the scrim is web-fed into the panel making machinery and placed in the resin prior to curing. The scrim is not saturated by the liquid resin so that the scrim, and ultimately the panel, retain their tear-resistant properties.

It is an object of this invention to significantly improve the tear resistance of a translucent fiberglass reinforced panel, especially panels used in truck trailers and bodies.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1, 2, 3, and 4 are plots of tear testing evaluations performed on panels according to the invention, and comparative examples.

Figure 5 is a cutaway view of a panel according to the invention.

Figure 6 depicts a truck trailer roof incorporating the panel according to the invention.

Figure 7 depicts a test fixture used to perform tear-strength tests.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention combines two very different types of reinforcement for FRP: chopped fiberglass roving and a scrim. Chopped fiberglass is a common raw material used to achieve desired mechanical strength properties in many fiberglass reinforced plastics. The fiberglass is usually supplied as bundled filaments chopped to short lengths on the order of 1.5 to 2.5 inches or so, although the length is not critical. The chopped fiberglass may be coated with a silane to improve its dispersibility in the resin mix of the FRP. To obtain the best physical properties of the finished plastic panel according to the present invention the chopped fiberglass generally comprises between about 20 and about 40 weight percent of the finished plastic panel. Most preferably, between about 28 and about 30 weight percent of the finished plastic panel is fiberglass fibers.

To make fiberglass reinforced plastic, the fiberglass fibers are mixed into a liquid resin matrix, which may be a polyester resin, epoxy resin, acrylic resin, or other resin. The preferred panel according to the invention comprises a thermoset polyester resin matrix into which fiberglass fibers are uniformly dispersed.

In a most preferred embodiment the resin is an orthophthalic polyester resin. The polyester resin generally comprises between about 37 percent and about 41 percent of the finished FRP panel.

The preferred polyester resin matrix incorporates one or more crosslinking monomers, present in an amount between about 10 weight percent and about 15 weight percent with respect to the liquid resin mix composition from which the panels are made. Monomers used for this purpose include, for example, certain acrylics, as would be recognized by one of ordinary skill in the art. In a preferred embodiment, the crosslinking monomers are styrene and methyl methacrylate.

FRP panels according to the invention may also include one or more inorganic fillers such as a clay filler, silicates, alumina or calcium carbonate. The inorganic filler imparts structural strength and also can impart other properties such as fire retardance, as disclosed in U.S. Patent No. 4,619,954, referenced above. The preferred inorganic fillers are calcium carbonate and silicates.

Particularly preferred resin mixtures according to the invention are those which yield a translucent panel upon curing. An excessive amount of fillers (more than about 40 weight percent) or pigments (more than about 1 weight percent) can cause a panel to be opaque rather than translucent. By way of example, and not limitation, a preferred amount of filler in the resin

mixture to obtain a translucent panel according to the invention is in the range from about 20 percent to about 40 percent. If pigment is used at all, the amount will be in the range between about 0.0 percent and about 1.0 percent.

The resin matrix typically will also include additives, such as UV stabilizers, surface active agents, pigments, dyes, and antioxidants in amounts less than about 1 percent by weight, respectively.

In a particularly preferred embodiment, the panel comprises a thermoset polyester resin; styrene monomer and methyl methacrylate monomer; inorganic fillers; conventional additives; chopped fiberglass; and scrim in the relative weight percentages set forth in Table 1 below. The weight percentages are given with respect to the finished FRP panel.

Table 1

Ingredient	Weight Percent
thermoset polyester resin	37-41
styrene monomer	3-4
methyl methacrylate monomer	3-4
inorganic fillers	16-18
additives	0.2-0.3
fiberglass	28-30
ETR fabric (scrim)	6-10

"Scrim" is a net-like fabric. Scrim is commonly used in building construction applications such as drywall tape and as a surfacing material in cement board, as disclosed in the referenced U.S. Pat. No. 5,763,043. To the inventors' knowledge, scrim has not heretofore been used in the production of an FRP panel, and a panel incorporating a scrim has not been used in a truck body or trailer roof.

The fabric used as a scrim should impart some tear resistance. Although any type of fabric could be used, the preferred fabric is a polyester or fiberglass fabric. Preferably, the scrim used according to the invention is an open-weave material, meaning that there are open spaces in the fabric weave. The dimensions of a weave are described by the number of strands per inch of width in both the machine ("warp") and cross-machine ("weft" or "fill") directions. Preferably, the scrim is an open weave polyester or fiberglass fabric having between 1 and 12 strands per inch, more preferably between 3 and 10 strands per inch, in both the machine and cross-machine directions. Most preferably, the scrim is an open weave polyester or fiberglass fabric having about 5 strands per inch in the warp and weft directions. The weight of the fabric is generally in the range of 2 ounces to about 10 ounces per square yard.

In particularly preferred embodiments, the scrim is treated with polymer so that it will not become saturated with the resin of the FRP panel during manufacture and lose its tear-resistant properties.

Any coating capable of preventing saturation with the resin of the FRP panel during processing is within the scope of the invention, and one of ordinary skill in the art should be able to identify such coating materials without undue experimentation. Particularly preferred coatings are selected from acrylics, polyvinyl chloride (PVC), styrene butadiene rubbers (SBRs), and ethylene vinyl acetate (EVA). The presently preferred coating is PVC.

The open weave fabric (scrim) may be used with or without a glass or polyester surfacing veil. A surfacing veil is a lightweight fine fabric proximate the surface of the panel which soaks up resin and gives the panel a smooth, resin-rich surface appearance.

An example of a scrim-reinforced FRP (10) is shown in Figure 5, having chopped fiberglass reinforcement (90) and the scrim (20) placed therein.

Figure 6 depicts a truck trailer (30) having a translucent scrim-reinforced FRP (10) incorporated therein. It will be readily understood by one of ordinary skill in the art that a truck body roof could easily be made with a panel according to the invention as well as a truck trailer roof. In a preferred embodiment, a translucent FRP panel according to the invention extends the width of the truck body or trailer roof and is affixed by rivets or other means to the vertical supports. Truck roof panels, according to the invention, generally have a width of about 100 to about 102 inches, although the exact width is not

critical, and is merely dictated by the limitations of the panel making machinery. In the most preferred embodiment, the scrim extends across the full width of the panel. The thickness of the panels is also not critical, but it is thought that economical embodiments having acceptably enhanced tear resistance will generally range between about 0.05 inch up to about 0.1 inch in thickness. The most preferred thickness for panels made according to the invention is between about 0.07 and about 0.08 inches.

Tear strength of the finished panels is measured in the test fixture of Figure 7 as follows: A square panel specimen (40) is prepared and bolted in a fixture (50) having two sets of clamps (60, 62) arranged along an edge (70) of the panel specimen and meeting at a point on the center line of the panel specimen. The panel specimen can be loaded into the fixture so that the center line is parallel to the machine direction, perpendicular to the machine direction or at an angle, such as 45 degrees, with respect to the machine direction. A load (80) is applied, subjecting a point on the center line of the panel specimen to shear. The load applied is plotted against the extension (or displacement) reached in a vertical direction by a portion of the specimen panel at the edge of the panel on the center line.

Figure 1 depicts the tear test results obtained from a test performed on a notched specimen prepared according to Example 4 in the cross-machine direction. Figure 2 depicts tear test results obtained from a test

performed on an un-notched specimen prepared according to Example 4 in the machine direction. Figure 3 depicts tear test results obtained from a test performed on a notched specimen prepared according to Comparative Example 4 (using woven roving in place of the scrim according to the invention) in the machine direction. Figure 4 depicts tear test results obtained from a test performed on an un-notched specimen prepared according to Comparative Example 2 in the machine direction.

As shown in Figures 1 through 4, initially the applied load is relatively high, until the extension of the panel reaches about 0.5 inches. This initial period is the period of "tear initiation." The "tear initiation load" as used herein is the maximum load reached until the panel reaches an extension of about 0.5 inches. To arrive at a "tear initiation strength," the tear initiation load is simply divided by the thickness of the panel. The "average tear initiation strength," as used herein, is the average of the values of the tear initiation strength obtained with the panel specimen loaded into the fixture in the machine and cross machine directions.

Also as shown in Figures 1 through 4, after the period of tear initiation, the slope of a line plotting applied load versus extension (or displacement) becomes relatively smaller. This is the "tear propagation" period.

To obtain the "tear propagation strength," as used herein, the average load applied in the tear propagation period until a displacement of 1.5 inches is achieved is divided by the thickness of the panel. The same tests are also performed on panel specimens that have each had a notch 1/16 inch wide by 1 inch long cut into center line (in the machine and cross-machine directions). The reported tear propagation strength is based on the average of the notched and un-notched specimens.

Tear propagation strengths are generally the same in both the notched and un-notched specimens, while tear initiation strength is affected by the notch -- strengths of the un-notched specimens being higher.

The panels according to the invention incorporating a scrim have a tear propagation strength greater than about 600 lb/in, up to 950 lb/in, or even higher. A preferred range of tear propagation strength for the panels according to the invention is between about 650 lb/in and about 900 lb/in. Otherwise identical FRP panels which do not incorporate a scrim have a tear propagation strength in the range of 200 to 500 lb/in. FRP panels made incorporating woven roving reinforcement, which is conventionally thought of as tear resistant, are surprisingly less tear-resistant than FRP panels according to the invention, incorporating a scrim. Contrary to conventional thinking, thin and cost-effective panels having enhanced tear resistance can be produced.

In a typical continuous FRP panel production machine, a catalyzed liquid resin mix formulation and chopped fiberglass are dispensed at the front of the machine. The chopped fiberglass is saturated with the liquid resin mix by various compaction methods and is deposited on a moving film support (i.e. continuously cast). The panel is cured as it passes through a series of temperature controlled ovens.

To improve the tear resistance of the FRP panel, a polymer-coated scrim is web fed to the panel machine and placed in the catalyzed liquid resin mix and chopped fiberglass composite prior to entering the curing ovens. By "web fed" is meant that the scrim is maintained under sufficient tension so that it is spread out in the resin, substantially co-extensively with the panel. In this manner, the scrim does not bunch up during manufacture, and tear resistance is provided over the entire extent of the panel. Alternatively, several wide strips of fabric can be placed in the resin composite. The polymer coating on the scrim material prevents the liquid resin mixture from saturating the scrim fibers. Because the scrim material is not saturated with the resin mixture, it retains its original tear resistant properties giving the FRP roof panel increased tear resistance.

Some fabrics that might be candidates to improve the tear resistance of an FRP panel will be found unsuitable because they are insufficiently "wet out" by the resin. This causes unacceptable voids in the finished panel. The inventors herein have found that

acrylic coated fabrics are less preferred in this regard. For this and other reasons, PVC coated polyester and fiberglass scrims are preferred, although other materials such as acrylic still could be used.

In the panel making process, the scrim can be placed in the resin on top of or underneath the chopped fiberglass reinforcement.

It is known in the art to utilize additional chopped fiberglass or woven roving along the edges of a panel for to increase the strength of FRP panels on the edges, where rivets or other fasteners are used. Fiberglass woven roving is not an open weave fabric, and in general, it is a completely different kind of reinforcement than a scrim. However, in certain embodiments, panels according to the invention may incorporate fiberglass woven roving reinforced edges.

EXAMPLES 1-3

Translucent panels were made in the above-described panel-making machinery from general purpose orthophthalic polyester resin commercially available from Ashland Chemicals under product name LB 5925-146. The composition of the resin mixture, including fillers and additives, was substantially as set forth in Table 1 above. Each of the panels were reinforced with chopped fiberglass in an amount of about 0.143 pounds per square foot. During manufacture, three different fabrics were web-fed to the panel-making machine prior to curing to produce panels within the scope of the

invention. The fabric was placed in the resin mix after the chopped fiberglass was added, with the result that the fabric was closer to the bottom side of the finished panel. The overall thickness of the panels was approximately .077 inches, with some variation as noted in Table 2 below. The fabrics utilized for this comparison were:

1. A glass fabric scrim, coated with polyvinyl chloride. The weave of the fabric 5 strands per inch in both the machine and cross-machine directions. The fabric had a weight of 5.7 oz/sq. yd.

2. A glass fabric scrim coated with ethylene vinyl acetate. The weave of the fabric 5 strands per inch in both the machine and cross-machine directions. The fabric had a weight of 4.4 oz/sq. yd.

3. A glass fabric scrim coated with polyvinyl chloride. The weave of the fabric 5 strands per inch in both the machine and cross-machine directions. The fabric had a weight of 5.2 oz/sq. yd.

COMPARATIVE EXAMPLE 1

A conventional translucent panel without a scrim was manufactured as a control. The panel had a thickness of about 0.077 inches, an overall weight of about 0.476 pounds per square foot and chopped fiberglass

reinforcement in an amount of about 0.143 pounds per square foot. The panel did not have a scrim, but was otherwise substantially comparable to the panels of the above Examples 1-3 according to the invention.

The tear strength of the finished panels was evaluated using the tear strength procedure described above. The results are tabulated in Table 2 below.

Table 2

Property	Example 1	Example 2	Example 3	Comp. Ex. 1
Thickness (in.)	0.081	0.076	0.076	0.077
Fabric Type	5x5 glass	5x5 glass	5x5 glass	N/A
Fabric Wt.	5.7 oz/yd^2	4.4 oz/yd^2	5.2 oz/yd^2	N/A
Panel Wt. (p.s.f.)	0.501	0.513	0.462	0.490
Average Tear Propagation Strength (lb/in.)	763.3	608.5	770.2	454.6
Average Tear Propagation Load (lb.)	57.3	45.6	57.8	34.1
Average Tear Initiation Strength (lb/in.)	4862	5862	5062	4431

All of the above fiberglass reinforced plastic panels, with the exception of the control, are within the scope of the invention.

It should be noted that the PVC-coated fabrics (Examples 1 and 3) yielded noticeably superior results. Both of the PVC coated fabrics produced about a 70 percent improvement in tear propagation strength compared to the control. The EVA-coated scrim produced a panel that had 34 percent greater tear resistance than the control. Tear initiation strength was better in the panel incorporating the EVA-coated scrim.

EXAMPLE 4 / COMPARATIVE EXAMPLE 2

To further evaluate the features and advantages of panels made according to the invention, three panels were prepared in the above-described continuous casting apparatus using general purpose polyester resin having approximately the composition described in Table 1 above. The following changes were made in the panel manufacture:

In Example 4, a carpet backing was web fed to the panel making machine and placed in the resin over the chopped fiberglass. The carpet backing used was made out of acrylic coated fiberglass, has a weave of 6x5 strands per inch and a fabric weight of 6 ounces per square yard.

In Comparative Example 2, woven fiberglass roving having a fabric weight of 18 oz per square yard was placed in the resin in place of the chopped fiberglass reinforcement and reinforcing scrim. The amount of woven roving reinforcement was 0.125 pounds per square foot of panel.

The control panel was a FRP panel having the general composition set forth in Table 1, except that no woven reinforcement of any kind was used.

Tear tests were performed on notched and un-notched specimen panels in both the cross-machine direction, and in the machine direction. Representative plots of applied load versus panel extension are shown in

Figures 1-4. The results are tabulated in Table 3 below.

Table 3

	Property	Example 4	Comp. Ex. 2	Control
Notched/ Machine Direction	Tear initiation strength (lb/in.)	1040	890	850
	Tear propagation strength (lb/in.)	730	597	563
Notched/ Cross-Machine Direction	Tear initiation strength (lb/in.)	1060	1073	1282
	Tear propagation strength (lb/in.)	724	664	487
Un-notched/ Machine Direction	Tear initiation strength (lb/in.)	5905	3694	4884
	Tear propagation strength (lb/in.)	560	554	491
Un-notched/ Cross-Machine Direction	Tear initiation strength (lb/in.)	4239	3682	4788
	Tear propagation strength (lb/in.)	680	741	601
	Overall Average Tear Initiation Strength (lb/in.)	3061	2335	2951
	Overall Average Tear Propagation Strength (lb/in.)	673	639	535

Among other things, the results demonstrate that woven roving is ineffective as a tear resistance enhancement, even when compared with the less-preferred open weave fabrics suitable for use with the invention, such as carpet backing.

It will be understood that while this invention has been described as being manufactured using a continuous FRP panel production machine, other machines such as a batch machine, also could be used. Moreover, this invention encompasses FRP panels which are made by hand.

The invention has been described in connection with preferred embodiments. The description is not intended to limit the invention defined by the appended claims. Moreover, modifications and alterations that would be apparent to one of ordinary skill in the art upon reading the specification are within the intended scope of the invention.

WE CLAIM:

1. A tear-resistant fiberglass reinforced plastic panel, comprising:

a resin;

an plurality of fiberglass filaments dispersed in said resin; and

an open weave scrim in the resin.

2. The tear-resistant fiberglass reinforced plastic panel of claim 1, wherein said scrim is an open-weave polyester or an open weave fiberglass fabric.

3. The tear-resistant fiberglass reinforced plastic panel of claim 2, wherein said scrim is substantially coextensive with said panel.

4. The tear-resistant fiberglass reinforced plastic panel of claim 3, wherein the panel comprises a thermoset polyester resin matrix, chopped fiberglass roving, and inorganic fillers.

5. The tear-resistant fiberglass reinforced plastic panel of claim 2, wherein said scrim is coated with a polymer.

6. The tear-resistant fiberglass reinforced plastic panel of claim 5, wherein said polymer coated on said scrim is effective to prevent the saturation of said scrim with a constituent resin of said fiberglass reinforced plastic panel.

7. The tear-resistant fiberglass reinforced plastic panel of claim 2, wherein said open-weave polyester or open-weave fiberglass fabric comprises between 1 and 12 strands per inch in both the warp and fill directions.

8. The tear-resistant fiberglass reinforced plastic panel of claim 5, wherein said polymer coated on said scrim is selected from the group consisting of acrylic polymers, polyvinyl chloride polymers, styrene butadiene rubbers, and ethylene vinyl acetate polymers.

9. A tear-resistant fiberglass reinforced plastic panel comprising a continuously cast substantially planar panel having a polyester or fiberglass scrim with between 1 and 8 strands per inch in each of the warp and fill directions cured in a thermoset polyester matrix to form said panel.

10. The tear-resistant fiberglass reinforced plastic panel of claim 9, wherein said panel is translucent.

11. A truck trailer comprising the translucent fiberglass reinforced plastic panel of claim 10.

12. The truck trailer of claim 11, wherein a roof portion of said truck trailer comprises said translucent fiberglass reinforced plastic panel.

13. A truck body comprising the fiberglass reinforced plastic panel of claim 9.

14. The tear-resistant fiberglass reinforced plastic panel of claim 9, wherein said panel is continuously cast and cured in curing ovens from a mixture of catalyzed liquid resin and chopped fiberglass, said catalyzed liquid resin saturating said chopped fiberglass, wherein said scrim is incorporated into said panel prior to curing and wherein said scrim is substantially coextensive with said panel.

15. The tear-resistant fiberglass reinforced plastic panel of claim 14, wherein said scrim is incorporated into said panel by web-feeding.

16. The tear-resistant fiberglass reinforced plastic panel of claim 14, wherein said scrim is polymer coated and said catalyzed liquid resin does not saturate said scrim.

17. The tear-resistant fiberglass reinforced plastic panel of claim 9, having an average tear propagation strength of greater than about 650 pounds per inch.

18. A method for making a tear-resistant fiberglass reinforced plastic panel, comprising:

(a) depositing fiberglass fibers and a resin matrix on a support,

(b) placing an open weave scrim in said resin matrix,

(c) curing said resin to form a panel, and

(d) removing said panel from said support.

19. The method of claim 18, wherein said step of placing the open weave scrim comprises web feeding the scrim such that the scrim is substantially coextensive with said panel.

20. The method of claim 18, wherein said scrim is a polyester or fiberglass scrim having between 1 and 8 strands per inch in the warp and fill directions, and said resin matrix comprises a thermoset polyester resin and an inorganic filler.

21. The method of claim 20, further comprising coating said scrim with a polymer prior to said step of placing the scrim.

22. The method of claim 21, wherein said polymer is an acrylic.

23. The method of claim 18, wherein said support is a moving support.

24. The method of claim 23, wherein said step of curing comprises moving said resin through a plurality of curing ovens.

FIG. 1

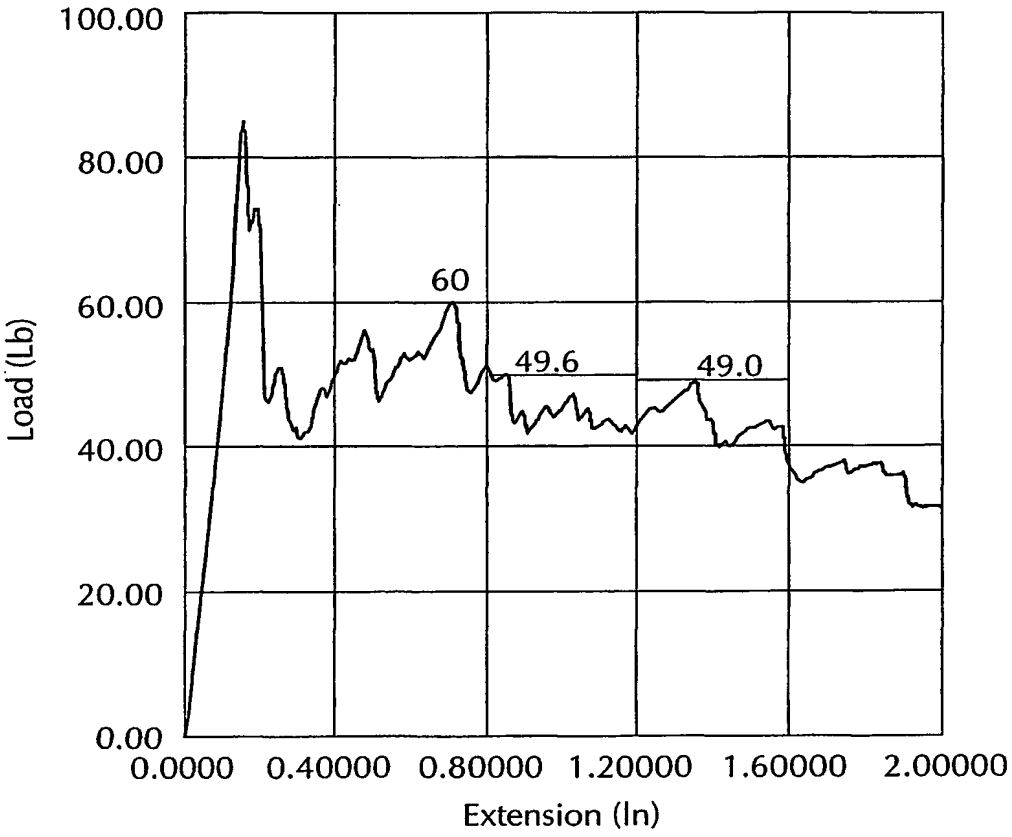
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FIG. 2

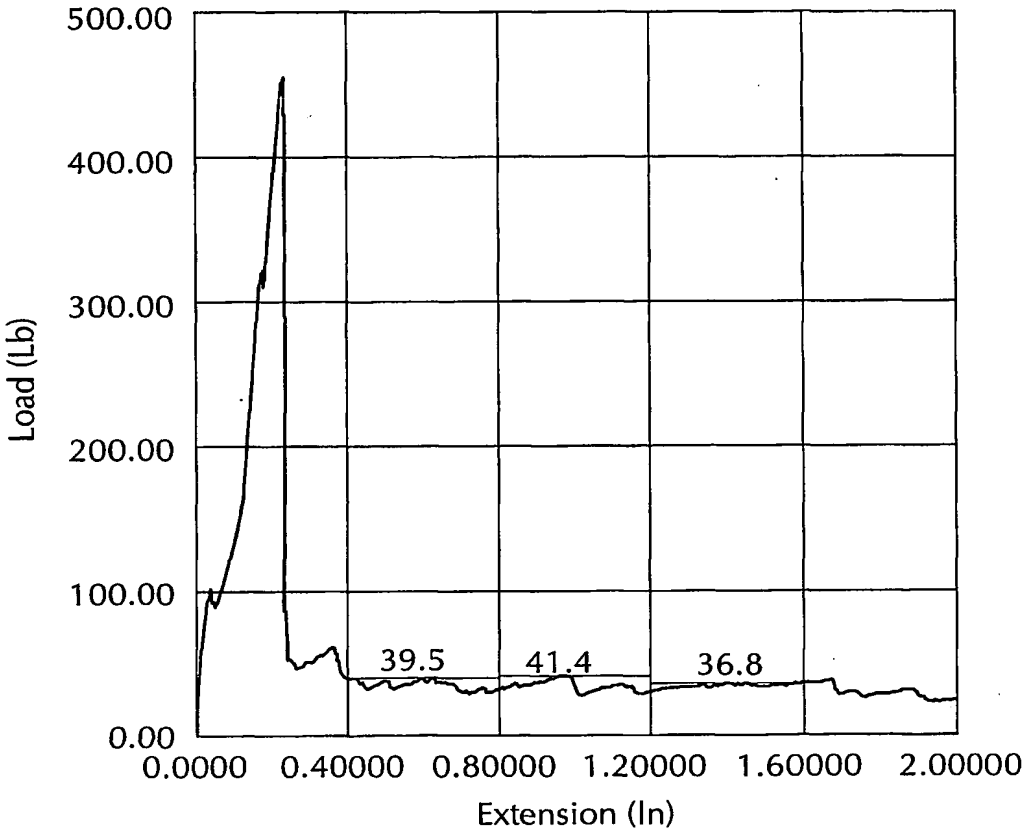
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FIG. 3

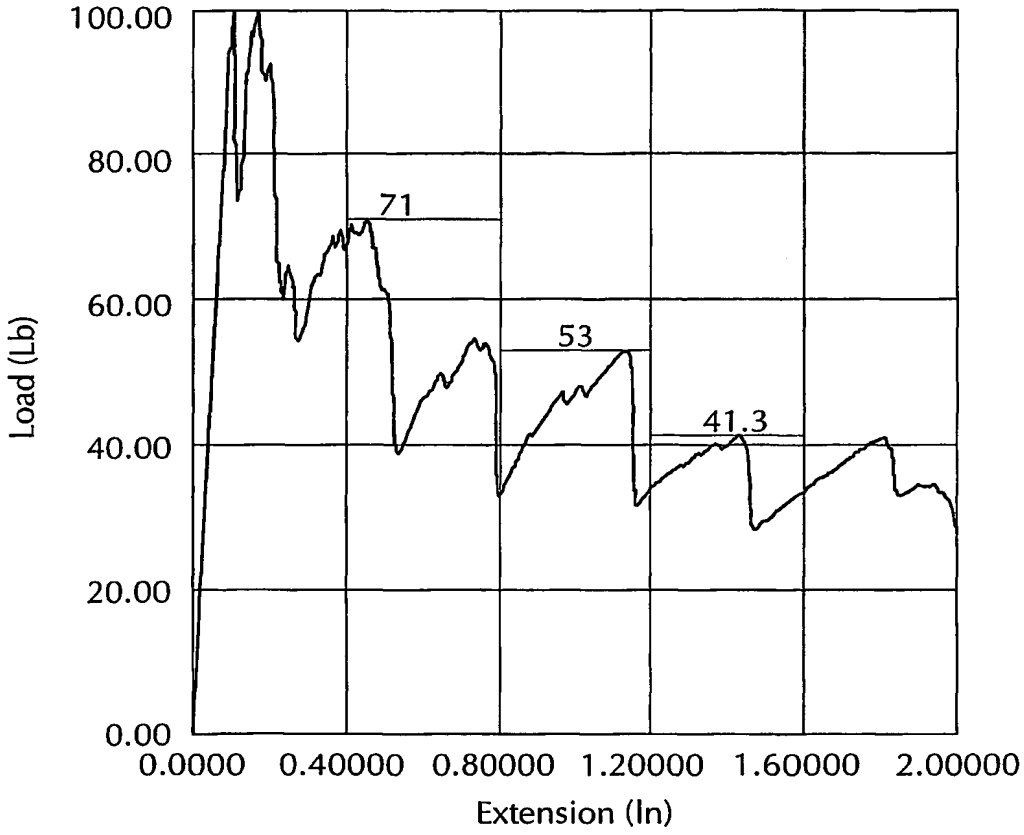
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FIG. 4

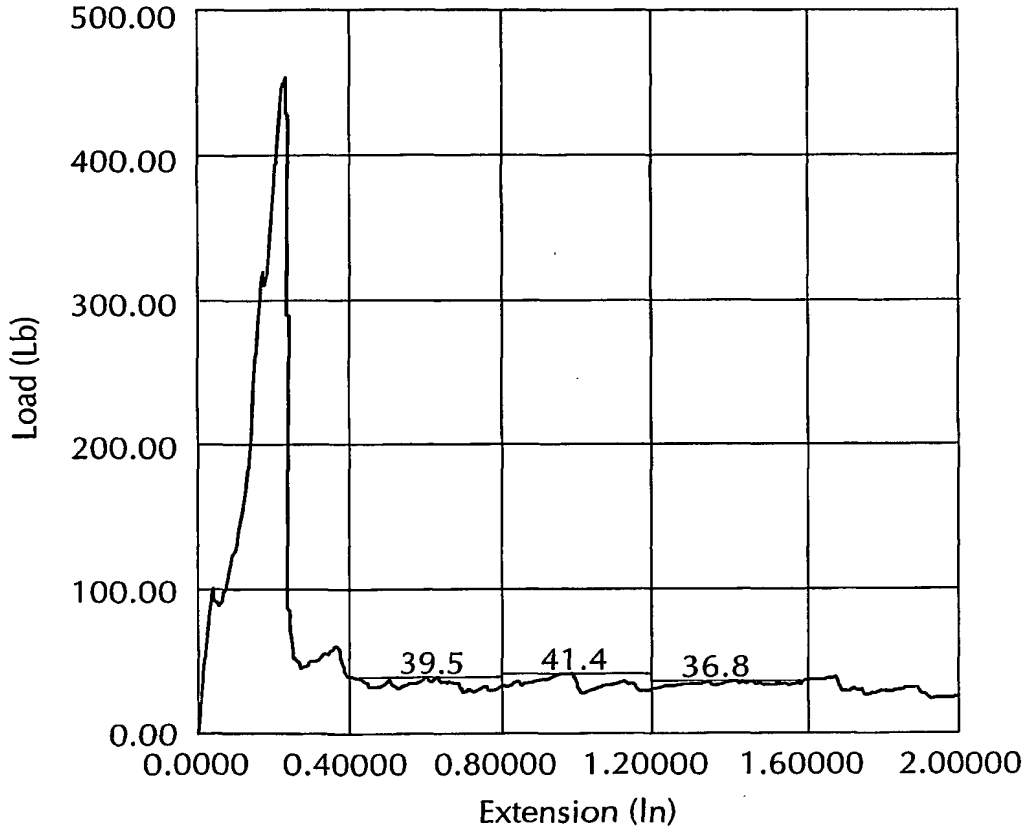
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FIG. 5

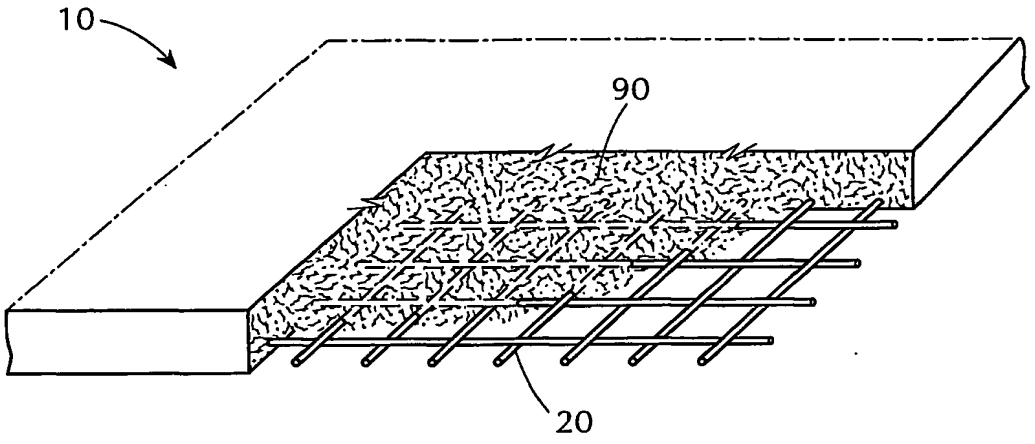


FIG. 6

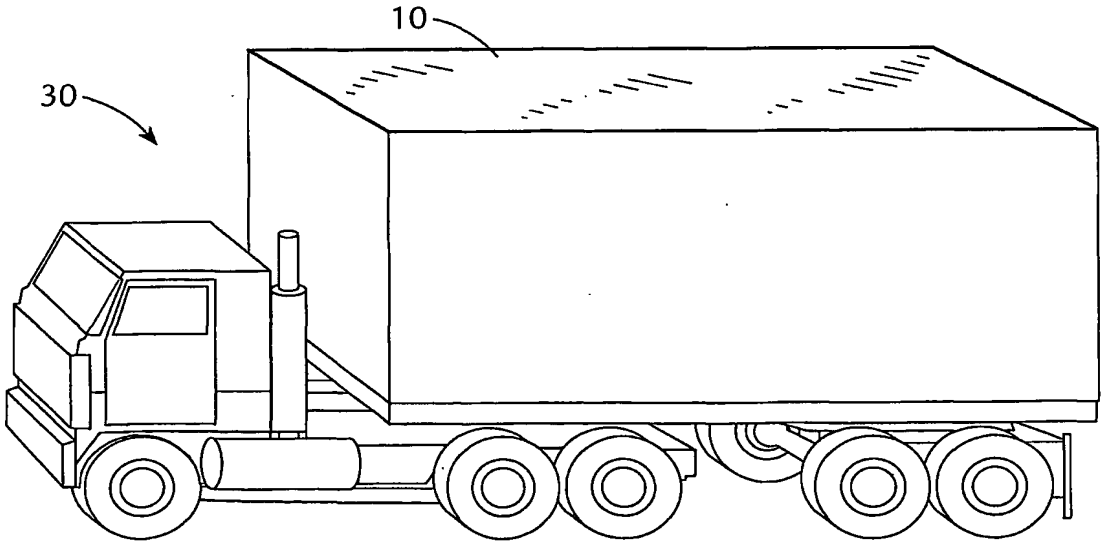
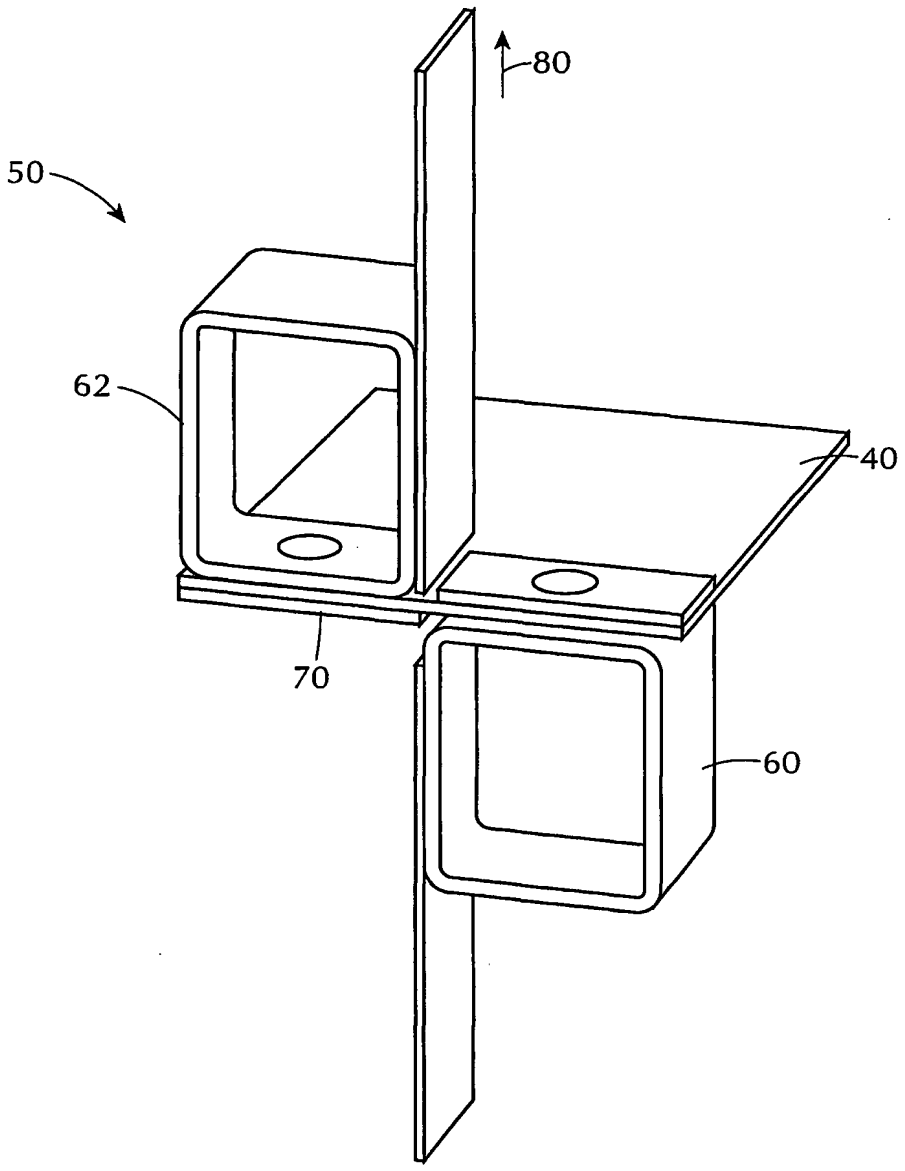


FIG. 7



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(74) Agents: DIANA, Leonard, P. et al.; Fitzpatrick, Cella, Harper & Scinto, 30 Rockefeller Plaza, New York, NY 10112-3801 (US).

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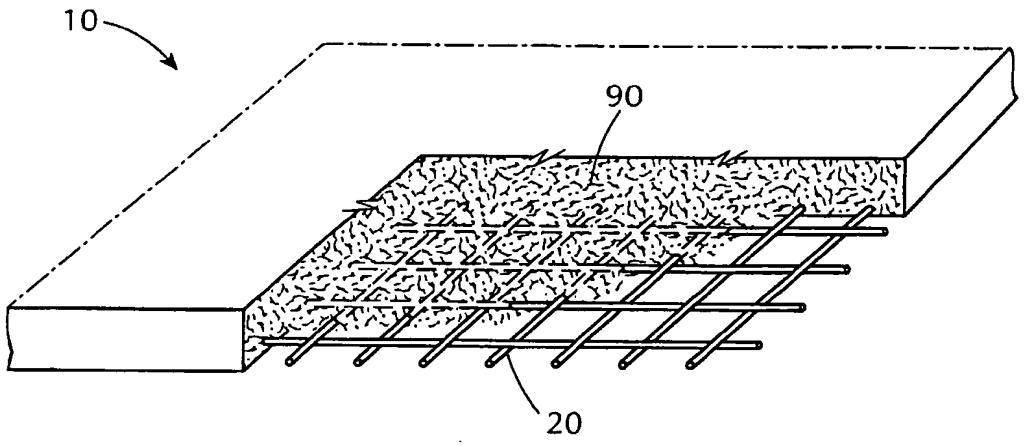
(54) Title: TEAR-RESISTANT FIBERGLASS REINFORCED PLASTIC PANEL AND METHOD OF MANUFACTURING SUCH PANELS



(57) Abstract: The invention is directed to fiberglass reinforced plastic panels (10) having increased tear resistance. Increased tear resistance is provided by an open-weave scrim (20) which is incorporated into the panel. The panels are useful in the manufacture of truck bodies and trailer roofs.

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Inter nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 416 660 A (BAY MILLS LTD) 13 March 1991 (1991-03-13) column 3, line 14-19 column 5, line 18 -column 6, line 7 figures 1-5	1-3,7
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Y	EP 0 185 169 A (BAY MILLS LTD) 25 June 1986 (1986-06-25) abstract page 4, line 23 - line 25 --- -/--	1-3,5,18

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2002	09/04/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Pierre, N

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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